Concussion Prevention
An Evidence Based Approach

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Thoughts

• Opinion... vs EBP
• “Currently, the best treatment for concussion appears to be prevention...”\(^1\)
• Generated 5 questions regarding concussion prevention.
• PICO for EBP
• Further analysis
5 questions

1. Do tighter rules prevent concussion in contact sports?
2. In youth sport, is the presence of a previous concussion enough to predict future concussion with complicated sequelae?
3. Does strengthening the neck and shoulder muscles prevent incidence of concussion in football athletes?
4. Can certain mouthpiece styles and fit prevent concussion in collision sports?
5. Can the presence of soccer head gear reduce the incidence of concussion in youth players?
4 PICO Questions

- **P** = Patient or population with the condition

- **I** = Intervention used - specific diagnostic test, treatment, adjunctive therapy, medication, etc.

- **C** = Comparison treatment (not always included in clinical question)

- **O** = Outcome relevant to you or the patient
Question #1:
Do tighter rules prevent concussion in contact sports?

P – Contact sport athletes

I – Evaluation of play that causes concussion and increasing enforcement of safer play

C – Number of concussions prior to rule changes

O – Decreased # of concussions from “legal” moves
Studies

Ref. 1 – Benson et al, overview of prevention strategies
Ref. 3 – Harmon et al – AMSSM position statement
Ref. 4 – Levy et al – Concussion in soccer overview
Ref. 5 – Powell – Cause and effects of Concussions
Ref. 7 – Queen et al – Impact force in soccer heading
P – Patient population

• Majority of concussions occur in:
  • FB, WR, GSC, BSC, GBK
  • HS and college ages\(^3\)
• Ice Hockey was evaluated in regard to rule changes also
I - Intervention

- Many governing bodies are pressured to make the sport safer
  - Youth Soccer (AYSO) through professional soccer (FIFA)
  - NFL penalties and fines for certain infractions
  - Decision makers should focus efforts on changes that minimize the potential for head impacts... 5
- Hx of rule changes
Helmets, skull fractures, cervical spine fractures, concussions... oh my!

- We know changing rules changes things (Risk Compensation article) ²
- Advantages and disadvantages of rule changes?
  - often unknown
I - Intervention

What rule changes have been considered or instated?

Soccer
- Sin-bin (penalty box)
- Goal prohibiting foul = ejection and pk versus yellow and pk
- Ball size and inflation
- Header count or consideration of heading the ball at all
- Unlimited substitutions to evaluate for head injury

High School Football Mercy rule = less opportunity for injury
- Out one play if helmet comes off
- Blocking below the waist, kicking team contact etc
- Spearing
- Helmet to head or neck contact first

[Link to NFHS 2014 rules changes]
C - Comparison

- Evaluate concussion numbers from years prior to rule change and after rule change
- Consider “side-effects” of rule changes
0- Outcome

Reduce number of concussion from “legal” moves.
Increase repercussions from “illegal” moves.

- “No sport is without concussion. Decision makers in sports safety should focus their prevention efforts on programs that minimize the potential for head impact collisions...”\(^5\) (2001 study)

Safer play over-all

- without compromising the spirit of the game?
- Coaches responsibility to teach safe techniques and monitor players \(^5\)
Soccer concussion could lead to rule changes

- Player to player contact – limited by officials???
Soccer concussion could lead to rule changes

Concussion injuries from heading the ball

- 6%-24% of reported concussions in soccer have been associated with contact with the ball \(^4\)
- Inflation pressure does not significantly effect force during a header \(^7\)

<table>
<thead>
<tr>
<th>TABLE 2. Summary of the results from the mathematical model.</th>
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<tbody>
<tr>
<td><img src="image" alt="Table Image" /></td>
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<tr>
<td>Change in ball inflation</td>
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<tr>
<td>Change in head mass</td>
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<tr>
<td>Change in ball size</td>
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<td>Zero vs infinite neck stiffness</td>
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9 PSI or 10 PSI
0 – Outcomes

• “…the most effective method to prevent concussion is to minimize the likelihood and/or severity of head impact.” Benson et al ¹
• Could this happen through rule changes?
• Consider trade-off injuries ¹
Question #2:
In youth sport, is the presence of a previous concussion enough to predict future concussion with complicated *sequelae*?

P – Youth sport athletes with hx of concussions

I – Recommend non-contact sport rather than allow contact sport for athletes with hx of concussions

C – Allow athletes with hx of concussions to play contact sports

O – Reduce the incidence of concussions with complicated sequelae from 3 or more concussions
Articles Examined

Ref. 3 – Harmon et al ³ AMSSM Position statement for concussion in sports
P - Patient

Athletes with a history of prior concussion

• Documented diagnosed multiple concussions or severe concussion
I - Intervention

Recommend changing sport or discontinuing sport for a period of time due to increased risk factor

• Concussion occur in any activity, regardless of the nature, we just need to consider likely hood of injury in that sport for that player

• The gray area of retiring athletes with repeated concussions
C – Comparison

- Allowing them to continue playing with an increased risk of concussion
  - 2-5.8 times higher risk\(^3\)
0 – Outcomes

• No clear evidence based guidelines for retiring based on number of concussions or other abnormality – Clinicians should carefully deliberate each case \(^3\)

• Consider all risk factors
  • Youth brain development \(^3, 6\)
  • Gender and sport (position) \(^3\)
0 - Outcomes

- Symptoms (number, severity and duration)\(^3\)
  - Are a predictor of prolonged recovery
- Thresholds with other risk factors \(^3\)
  - Mood disorders
  - Learning disorders / ADHD
  - Migraines
- These may be greater predictors of complicated sequelae
Summary of question 2

Question #2:
In youth sport, is the presence of a previous concussion enough to predict future concussion with complicated sequelae?

- Case by case evaluation
- Consider previous concussion symptom severity and duration
- Not sure there is a clear answer out there
Question #3: Does strengthening the neck and shoulder muscles prevent incidence of concussion in contact sport athletes?

P – Contact sport athletes

I – Neck strengthening exercises during preseason and during season training sessions

C – Athletes not participating in strengthening programs

O – Reduce the incidence of concussion in higher risk sports program
Articles Examined

• Ref. 1 – Benson et al, overview of prevention strategies
• Ref. 3 – Harmon et al, AMSSM position statement
• Ref. 6 – Collins et al, HS athletes studied to use neck strength as a predictor of concussion risk
• Ref. 7 – Queen et al, youth soccer athletes head mass, ball inflation, and head acceleration
• Ref. 8 – Almosnino et al, Force-Time Variables of Neck Muscles...
• Ref. 9 – Mansell et al, Head-neck dynamic Stabilization
• Ref. 10 – Schmidt et al, Cervical muscle characteristics on head impacts in football
P – Patient

- Contact sport athletes (studies included youth, HS and college players of varied sports)
I – Intervention

• Implement neck muscle strengthening programs to decrease risk of concussion in contact sports
C – Comparison

• No formal strengthening or neuromuscular facilitation program initiated
0 – Outcomes

• Varied or inconclusive results across the studies examined over the last 10-15 years
0 – Outcomes

• Harmon et al \(^3\) (AMSSM)
• concluded in 2013 that neck strength hasn’t been proven as a significant intervention
  • Especially when there is no opportunity to “prepare for the hit” such as in rules infractions
  • “Theorized” that increased head-neck stiffness could decrease acceleration forces
0 – Outcomes

- Benson et al - “...Effective risk-reduction strategies in sport concussion.”
  - Looked at selected studies regarding neck strength
    - Many measured strength isometrically not dynamically
    - Failure to measure muscle activation associated with head impact
    - Failure to control for level of anticipation
    - Lack of control for previous concussion hx
0 – Outcomes

• Collins et al.\textsuperscript{6}

• 3 Objectives

1. Develop and validate a cost effective tool to measure neck strength among athletes in high school setting

2. Conduct a feasibility study to determine if the hand-held tension scale could be reliably utilized in a HS setting by ATs to measure neck strength

3. Conduct a pilot study to determine if anthropometric measurements captured by ATs can be used to \textbf{predict} concussion risk among high school soccer, basketball and lacrosse players
O – Outcomes

- Collins et al. 6
- Sample size of 6,662 HS age M/F soccer, lacrosse and basketball athletes
- measured by ATs with different levels of experience
- 51 schools across the US over 2 years
- Pre-season measures of neck strength and circumference compared to post-season concussion data using a unique identifier
- 4 neck strength measures isometrically
0 – Outcomes

• Collins et al 6
• Results:
  • The cost effective tool is a valid test tool
  • High inter-tester reliability strong correlation
  • After adjusting for gender and sport, overall neck strength remained a significant predictor of concussion.
  • For every 1 pound increase in neck strength, odds of concussion decreased by 5 %
  • Ratio between neck length and head circumference was not a significant predictor of concussion
0 – Outcomes

- Collins et al.\textsuperscript{6}
- “Promising results indicate targeted neck strengthening programs should be developed...”
- Did not evaluate dynamic stabilization, reaction time, or “stiffness”
0 – Outcomes

- Almosnino et al. 8 “Peak force (PF) might not be relevant to investigate the role of neck muscle strength in injury prevention because in real-time play athletes may not reach maximal muscle force before contact.”
  - Poor relative awareness of contact
  - Limited time to generate force
- “Early force-generating capacity of neck muscles might be more meaningful”
0 – Outcomes

Almosnino 8
PF = peak force
RFD = Rate of force development
$T_{50PF} = \text{Time to reach 50\% of peak force}$

- Custom built device
- No hx of neck/head issues
- 26 individuals
- Males 21.6 +/- 2.1
- 2 trials
- No hx of neck strengthening programs
- 5 directions to max force as quickly as possible
- Hockey helmet
0 - Outcomes

• Almosnino 8
• Rate of force development more pertinent than peak force
• They have a device to measure peak force through 5 ranges of motion
• Athletes don’t usually have the opportunity to attain peak force
0 - Outcomes


Objective:
To determine the effect of an 8-week resistance training program on head-neck segment dynamic stabilization
0 - Outcomes

Mansell 9 Subjects/methods

- 36 NCAA Soccer Players (17 M & 19 F)
- 9 Male resistance training (RT) with 8 male control
- 10 Female RT with 9 female control
- RT Intervention = 8 wk flexion/extension resistance at 55% and 70% of 10RM, 3x10, 2x/week isotonic resistance training equipment
- Control group did no cervical resistance training
O - Outcomes

Mansell 9 Methods
- Pre and post-testing 8 week program
- Isometric testing
- External Force Applicator (commonly used dynamic restraint system)
- Motion analysis system
- EMG study
- Head-neck stiffness assessment

Figure 1. Forced extension trial setup with external force applicator.
0 - Outcomes

Mansell⁹ Results
• RT group got “stronger” as shown with increases in isometric strength and neck girth
• No reduction in head-neck acceleration on force application after 8 weeks of training
• Traditional strength training did not enhance “dynamic restraint” during force application in either gender
• Future considerations to plyometric type training to enhance neuromuscular changes

Physioball
Dynamic stabilization in all ranges
Bridges
Pictures???
0 – Outcomes

Ref. 10 - Schmidt et al.

Objective:
Determine if there are higher or lower head impacts in football between athletes with higher or lower preseason performance on cervical muscle characteristics
0 – Outcomes

Ref. 10 - Schmidt et al.

Methods:

• 49 HS/college football players
• Pre-season testing of isometric strength, muscle size, and response to cervical perturbation (kinematic and EMG studies)
• Divided into high or low performers
• Measured head impact biomechanics using Symbex “HITS” System in Revolution or Speed Helmet
O – Outcomes

Ref. 10 - Schmidt et al.

Conclusions:

• Greater cervical stiffness and angular displacement (stiffer necks during anticipated forced extension) after a perturbation may reduce the odds of head high impact

• Don’t eliminate strength programs
  • add neuromuscular training to enhance cervical muscle dynamic response could reduce the odds of high impacts
Question #4:
Can certain mouthpiece styles and fit prevent concussion in collision sports?

P – Football athletes

I – Custom (LM or CMO) mouthpieces for all players

C – Boil and bite OTC mouthpieces

O – Prevent concussions in collision sports
Articles Referenced

Ref. 11 – Barbic et al. Compared “Brain Pad” to common team issued mouth guards. 2005.

Ref. 12 – Winters et al. Role of mouth guards in reducing concussion in HS football. 2014
0 – Outcomes

Ref. 11 – Barbic et al.

Methods:

• Canadian university male football or male and female rugby athletes
• Compared typical rate of concussions to “Brain Pad” group
• 1 season
0 – Outcomes

Ref. 11 – Barbic et al.

Conclusion:

• This type of mouth guard was not proven to reduce concussions

• 43 observed with concussions consistent with typical % of athletes concussed in other mouth guards in other controlled studies
0 – Outcomes

Ref. 12 – Winters et al.

Methods

• Studied the relationship between custom-made pressure laminated (LM)
  • (also been called custom mandible orthotic)
• 412 HS football athletes
• 220 in LM
• 192 in OTC
0 – Outcomes

Winters et al

- 3-4 mm is recommended
- LM avg. 3.5 mm
- Only 4 of the OTC were 3mm thick 2%
- Condition of LM and OTC were evaluated post season
0 – Outcomes

Ref. 12 – Winters et al.

Results:

• 24 concussion out of 412 athletes occurred in this test group (5.8%)
• 8 were wearing an LM >3 mm thick
  • 8/220 in LM or 3.6%
• 13 were wearing an OTC MG < 2.5 mm thick, 1 player had two concussions, 2 players were not wearing mouth guards
  • 16/192 in OTC or 8.3%
• 2 to 1 ratio between two groups
• Other studies did not measure the thickness in the posterior occlusal area
0 – Outcomes

My Conclusion:

• Could reduce concussive effects from hits to the jaw
• or with jaw clenched in place as promoted by LM (CMO) increasing the stiffness
• Why not?
• Consider condition of all mouth pieces
Question #5:
Can the presence of soccer head gear reduce the incidence of concussion in youth players?

P – Youth soccer players

I – Approved soccer protective head gear

C – No head gear

O – Prevent concussions in soccer
For each question

• Study or studies overview
• Results
• Limits
• Practical application
• Personal experience (not EBP)
• FHS FB Concussions
  • 2012 – 18
  • 2013 – 25
  • 2014 – 19

• 2014 initiated traditional neck strengthening spring of 2014

• Added an option for LM/CMO through a dentist
Thank you!
References

References

